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Indian Creek Reservoir Rapides Parish, Louisiana

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

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16. ABSTRACT:

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT

ON

INDIAN CREEK RESERVOIR

RAPIDES PARISH

LOUISIANA

EPA REGION VI

WORKING PAPER NO. 541

WITH THE COOPERATION OF THE

LOUISIANA WILD LIFE AND FISHERIES COMMISSION

AND THE

LOUISIANA NATIONAL GUARD

MARCH, 1977

REPORT ON INDIAN CREEK RESERVOIR

RAPIDES PARISH, LOUISIANA

EPA REGION VI

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 541

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

March 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Louisiana Wild Life and Fisheries Commission, Division of Water Pollution Control for professional involvement, to the Louisiana National Guard for conducting the tributary sampling phase of the Survey, and to those Louisiana wastewater treatment plant operators who provided effluent samples and flow data.

Robert A. Lafleur, Chief; J. Dale Givens, Assistant Chief; Lewis R. Still, Biologist; Louis Johnson, Biologist; Lee Caubarreaux, Biologist; Darrell Reed, Engineer; Dempsey Alford, Biologist; and Elwood Goodwin, Water Quality Control Technician, all of the Louisiana Wild Life and Fisheries Commission, Division of Water Pollution Control reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

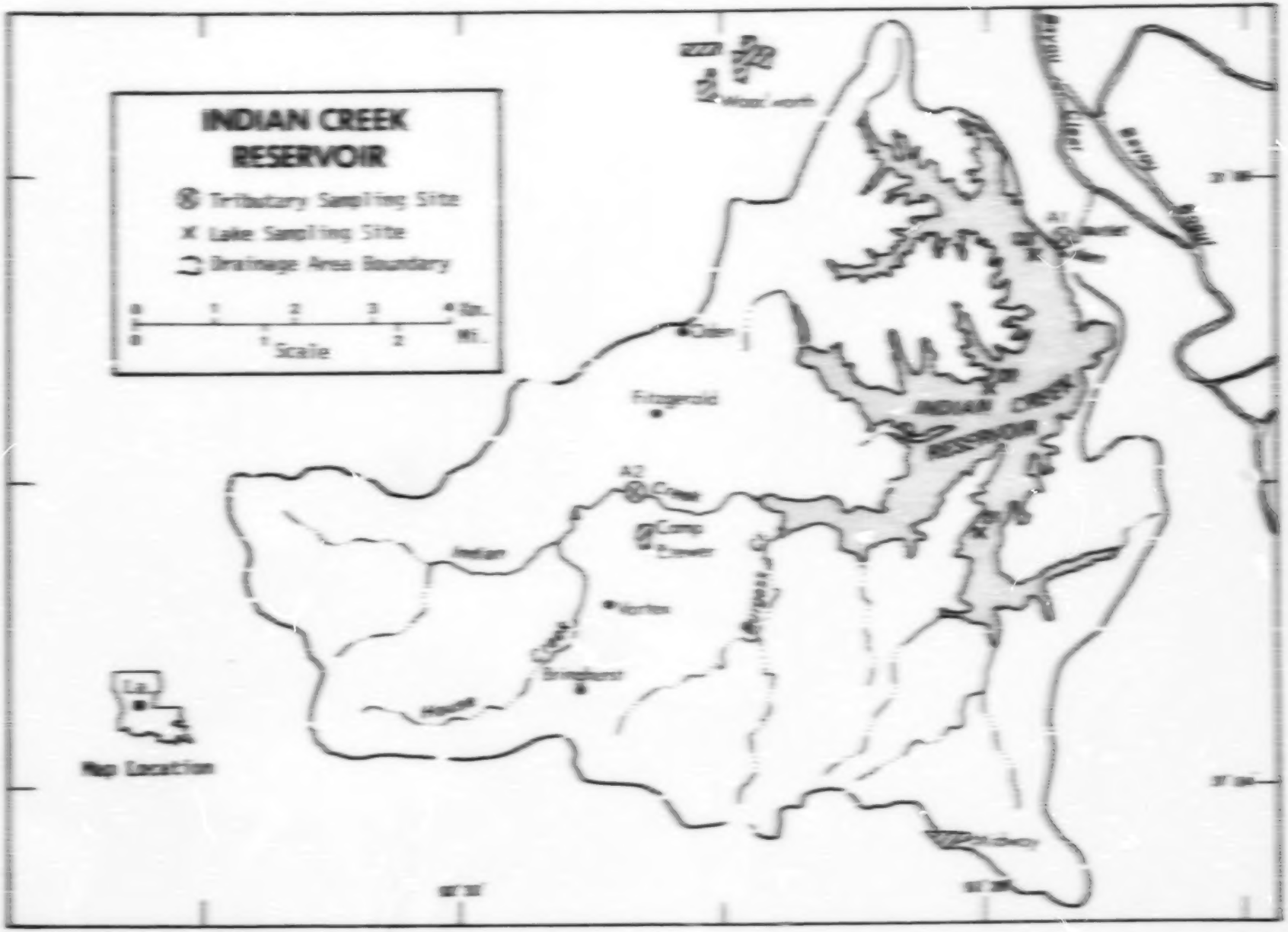
Major General O'Neil Daigle, Jr., the Adjutant General of Louisiana, and Project Officer Colonel Lawrence P. Dupre, who directed the volunteer efforts of the Louisiana National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF LOUISIANA

LAKE NAME	PARISH
Anacoco Lake	Vernon
Lake Bistineau	Bienville, Webster
Black Bayou	Caddo
Black Lake	Natchitoches and Red River
Bruin Lake	Tensas
Bundick Lake	Beauregard
Caddo Lake	Caddo (Menon and Harrison in Texas)
Cocodrie Lake	Concordia
Cocodrie Lake (Lower)	Rapides
Concordia Lake	Concordia
Cotile Lake	Rapides
Cross Lake	Caddo
D'Arbonne Lake	Union
False River Lake	Pointe Coupee
Indian Creek Reservoir	Rapides
Saline Lake	LaSalle
Turkey Creek Lake	Franklin
Lake Vernon	Vernon
Lake Verret	Assumption


INDIAN CREEK
RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Scale
Fitzgerald
Ocilla
Ocilla
Irwinville
Irwinville
Irwinville

REPORT ON INDIAN CREEK RESERVOIR, LOUISIANA

STORET NO. 2213

I. CONCLUSIONS

A. Trophic Condition:*

Survey data indicate Indian Creek Reservoir is eutrophic, i.e., nutrient rich and highly productive. Whether such nutrient enrichment is to be considered beneficial or deleterious is determined by its actual or potential impact upon designated beneficial water uses.

Chlorophyll *a* levels ranged from 5.7 µg/l in the spring to 63.8 µg/l in the summer with a mean of 21.5 µg/l. Secchi disc visibility and potential for primary production as measured by algal assay control yield was low. Of the 19 Louisiana lakes sampled by National Eutrophication Survey (NES) in 1974, 16 had higher median total phosphorus levels, 12 had higher median dissolved orthophosphorus values, but only 5 had higher median inorganic nitrogen levels than Indian Creek Reservoir.

Survey limnologists did not observe any concentrations of algae but did note abundant macrophytes in the shallows along coves and among the dead submerged trees near shore. Near-depletion of dissolved oxygen occurred in the hypolimnion at all stations in May.

*See Appendix E.

B. Rate-Limiting Nutrient:

Algal assay results indicate that Indian Creek Reservoir is limited by available phosphorus. Spikes with phosphorus or phosphorus and nitrogen simultaneously resulted in increased assay yields. The addition of nitrogen alone did not produce a growth response. The lake ratios of total available inorganic nitrogen to orthophosphorus (N/P) substantiate those results for the spring and summer sampling seasons, but indicate nitrogen limitation for the fall sampling season.

C. Nutrient Controllability:

1. Point sources -

There are no known point sources impacting Indian Creek Reservoir. The phosphorus loading of 0.06 g $P/m^2/yr$ is less than the "oligotrophic" level established by Vollenweider (1975) for a lake with such mean depth and detention time. However, loading calculations yield an apparent net export of phosphorus from the lake. This could be due to unknown and unmeasured point sources discharging directly to the lake, to insufficient sampling or to underestimation of the phosphorus load from septic tanks. Additional sampling is needed before an actual nutrient budget for Indian Creek Reservoir can be determined. However, regardless of the primary nutrient limitation suggested by either algal assay or nutrient ratios, the

most feasible approach to nutrient control, if desirable, is through available phosphorus control technology.

2. Nonpoint sources -

The phosphorus exports of nonpoint sources accounted for the entire phosphorus load to Indian Creek Reservoir during the sampling year. Indian Creek contributed 21.6% of the load, and ungaged tributaries were estimated to account for 49.6% of the total. The Indian Creek export rate of 8 kg $P/km^2/yr$ is somewhat lower than the rates of other streams in this area.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

Lake and drainage basin characteristics are itemized below. Lake morphometry data were provided by the State of Louisiana. Tributary flow data were provided by the Louisiana District Office of the U.S. Geological Survey (USGS). Outlet drainage area includes the lake surface area. Mean hydraulic retention time was obtained by dividing the lake volume by the mean flow of the outlet. Precipitation values are estimated by methods as outlined in NES Working Paper No. 175. A table of metric/English conversions is included as Appendix A.

A. Lake Morphometry:

1. Surface area: 9.11 km^2.
2. Mean depth: 3.4 meters.
3. Maximum depth: 6.6 meters.
4. Volume: 30,857 x 10^6 m^3.
5. Mean hydraulic retention time: 441 days.

B. Tributary and Outlet (see Appendix B for flow data):

1. Tributaries -

Name	Drainage area(km^2)	Mean flow (m^3/s)
A-2 Indian Creek	14.8	0.21
Minor tributaries and immediate drainage -	34.4	0.60
Totals	49.2	0.81
2. Outlet - A-1 Indian Creek	58.3	0.81

C. Precipitation:

1. Year of sampling: 187.9 cm.
2. Mean annual: 150.2 cm.

III. LAKE WATER QUALITY SUMMARY

Indian Creek Reservoir was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton identification and enumeration. During the first and last visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 4.6 meters at Station 01, 4.6 meters at Station 02, and 6.1 meters at Station 03. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix C and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/22/74	1. Merismopedia	2,990
	2. Melosira	2,036
	3. Schizochlamys	867
	4. Cyclotella	737
	5. Flagellates	693
	Other genera	2,599
	Total	9,922
05/30/74	1. Lunate celled colony	979
	2. Flagellates	287
	3. Kirchneriella	276
	4. Nitzschia	270
	5. Chlamydomonas	260
	Other genera	2,224
	Total	4,296
11/12/74	1. Cyclotella	1,885
	2. Melosira	956
	3. Merismopedia	697
	4. Cryptomonas	494
	5. Kirchneriella	387
	Other genera	936
	Total	5,155

f. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (ug/l)
03/22/74	01	5.7
	02	9.3
	03	7.6
05/30/74	01	42.6
	02	30.5
	03	63.8
11/13/74	01	9.9
	02	12.5
	03	11.6

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. 03/22/74

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.010	0.133	0.2
0.05 P	0.060	0.133	5.2
0.05 P + 1.0 N	0.060	1.133	19.6
1.00 N	0.010	1.133	0.2

b. 11/21/74

Spike(mg/l)	Ortho P Conc.(mg/l)	Inorganic N Conc.(mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.009	0.154	0.8
0.05 P	0.059	0.154	5.4
0.05 P + 1.0 N	0.059	1.154	16.1
1.00 N	0.009	1.154	0.7

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential for primary productivity was low in Indian Creek Reservoir during the spring sampling season and moderate during the fall. The lake was phosphorus limited at those times, as indicated by increased yields of the test alga in response to additions of orthophosphorus. Spikes with phosphorus and nitrogen simultaneously resulted in maximum yields. In both assays, spikes with nitrogen alone did not produce any responses beyond the control yields.

The N/P in the spring and summer lake data was 17/1 indicating phosphorus limitation. The ratio for the fall data was 13/1 suggesting that nitrogen and phosphorus were colimiting.

It should be noted that significant chemical changes took place in Louisiana lake samples between collection and assay analysis. The assay data should be considered in this context and until such differences are resolved, used with caution for any prediction of actual lake conditions. Such chemical changes are likely to alter the control yield as well as modifying the N/P ratio.

IV. NUTRIENT LOADINGS
(See Appendix D for data)

For the determination of nutrient loadings, the Louisiana National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff months of March and April (also February for Station 2213A1) when two samples were collected. Sampling was begun in June 1974, and was completed in May 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Louisiana District Office of the USGS for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of the USGS computer program for calculating stream loadings. Nutrient loads indicated for tributaries are those measured minus known point source loads, if any.

Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of USGS) were estimated by using the mean annual nutrient loads, in $kg/km^2/yr$ in Indian Creek A-1 and multiplying the means by the ZZ area in km^2.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Indian Creek	120	21.6
b. Minor tributaries and immediate drainage (nonpoint load) -	275	49.6
c. Known municipal STP's - None		
d. Septic tanks* -	<5	<0.1
e. Known industrial - None		
f. Direct precipitation** -	160	28.8
Total	555	100.0%

2. Outputs - A-1 Indian Creek 1,085

3. Net Annual P export*** - 530

*Estimate based on 1 lakeside camp.
**Estimated (See NES Working Paper No. 175).
***Export probably due to unknown sources and/or sampling error.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (nonpoint load) -		
A-2 Indian Creek	2,660	14.2
b. Minor tributaries and immediate drainage (nonpoint load) -	6,190	33.0
c. Known municipal STP's - none		
d. Septic tanks* -	70	0.4
e. Known industrial - none		
f. Direct precipitation** -	9,835	52.4
Total	18,755	100.0
2. Outputs - A-1 Indian Creek	18,030	
3. Net Annual N Accumulation	725	

D. Mean Annual Nonpoint Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Indian Creek	8	180

*Estimate based on 1 lakeside camp.
**Estimated (See NES Working Paper No. 175).

f. Yearly Loadings:

In the following table, the existing phosphorus annual loading is compared to the relationship proposed by Vollenweider (1975). Essentially, his "eutrophic" loading is that at which the receiving waters would become eutrophic or remain eutrophic; his "oligotrophic" loading is that which would result in the receiving water remaing oligotrophic or becoming oligotrophic if morphometry permitted. A "mesotrophic" loading would be considered one between "eutrophic" and "oligotrophic".

Note that Vollenweider's model may not apply to lakes with short hydraulic retention times or in which light penetration is severely restricted by high concentrations of suspended solids in the surface waters.

	Total Yearly Phosphorus Loading ($g/m^2/yr$)
Estimated loading for Indian Creek Reservoir	0.06
Vollenweider's "eutrophic" loading	0.33
Vollenweider's "oligotrophic" loading	0.16

V. LITERATURE REVIEWED

U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

Vollenweider, R. A. 1975. Input-Output Models With Special Reference to the Phosphorus Loading Concept in Limnology. Schweiz. Z. Hydrol. 37:53-84.

VI. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B

TRIBUTARY FLOW DATA

[illegible] HYDROGRAPH FLOW INFORMATION FOR LOCATIONS [illegible]

LAKE CASE 2011 ENGLISH UNITS

TOTAL TRIBUTARY AREA OF LAKE(S) = [illegible]

TRIBUTARY	SUBBASIN AREA (SQ MI)	JAN	FEB	MAR	APR	MAY	UNREGULATED FLOW(CFS) JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
221341	[illegible]	1.45	1.85	1.48	0.49	0.71	0.42	0.31	[illegible]	0.34	0.34	0.92	1.02	[illegible]
221342	34.9	0.27	0.27	0.29	0.25	0.19	0.19	[illegible]	[illegible]	0.21	0.24	0.21	0.31	[illegible]
221327	43.5	0.76	0.76	0.47	0.74	0.54	0.41	[illegible]	[illegible]	0.45	0.48	0.52	0.41	[illegible]

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = [illegible] TOTAL FLOW IN : [illegible]
SUM OF SUBDRAINAGE AREAS = [illegible] TOTAL FLOW OUT = [illegible]

[illegible] DAILY FLOWS AND DAILY FLOWDEPTHS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
221341	2	74	0.488	9	0.396				
	7	74	0.539	6	0.382				
	8	74	0.510	10	0.463				
	9	74	0.509	7	0.425				
	10	74	0.425	3	0.425				
	11	74	0.458	4	0.425				
	12	74	0.359	8	0.8				
	1	75	1.424	11	0.4				
	2	75	0.488	9	0.8	28	0.4		
	3	75	0.859	9	0.348	22	0.739		
	4	75	0.454	4	0.425	29	0.539		
	5	75	2.719	3	0.347				
221342	6	74	0.176	9	0.244				
	7	74	0.247	6	0.242				
	8	74	0.138	10	0.226				
	9	74	0.233	7	0.237				
	10	74	0.158	3	0.226				
	11	74	0.217	4	0.219				
	12	74	0.346	8	0.213				
	1	75	0.255	11	0.468				
	2	75	0.170	9	0.244	28	0.233		
	3	75	0.255	9	0.247	22	0.284		
	4	75	0.207	4	0.219	29	0.239		
	5	75	0.648	3	2.324				

APPENDIX C

PHYSICAL AND CHEMICAL DATA

[illegible]

[illegible]

[illegible]

APPENDIX B

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

APPENDIX E

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1974

STATE OF LOUISIANA

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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